

WHAT IS CLAIMED IS:

- Sub 33
1. A method of providing input feedback in a device having a keyboard with a matrix of independent keys having associated switches, the method comprising scanning the matrix for activated keys;
upon detection of a first activated key, providing provisional output to a user indicating that the activated key has been registered;
continuing to scan the matrix for activation of an adjacent key prior to release of the first activated key; and,
in response to activation of an adjacent key prior to release of the first activated key, providing final output to the user indicating that a combination of the first and adjacent keys has been registered, to the exclusion of the provisional output.
 2. The method of claim 1 wherein the final output is provided as visual feedback.
 3. The method of claim 2 wherein the provisional output is also provided as visual feedback.
 4. The method of claim 2 wherein the provisional output is also provided as audio feedback.
 5. The method of claim 1 wherein scanning the matrix includes scanning rows and columns.
 6. The method of claim 1 wherein scanning the matrix includes driving two adjacent rows simultaneously, seeking for two simultaneous output columns.
 7. The method of claim 1 wherein continuing to scan the matrix for activation of an adjacent key includes determining if a diagonally adjacent key is activated.

1 8. The method of claim 1 including looking up a desired combination key in an
2 internal table in response to activation of an adjacent key prior to release of the first activated
3 key.

1 9. The method of claim 1 wherein providing provisional output includes storing
2 the provisional output as raw data into a register.

1 10. The method of claim 1 wherein the provisional output is provided as feedback
2 and wherein providing the provisional output includes
3 determining the provisional output upon detection of the first activated key, and then
4 delaying a predetermined amount of time after the provisional output is determined
5 before providing feedback.

1 11. The method of claim 10 wherein the provisional output is provided as visual
2 feedback.

1 12. The method of claim 10 wherein the predetermined amount of time is
2 approximately 20 milliseconds.

1 13. The method of claim 10 wherein the amount of delay time is determined from
2 measured time between key strokes and details of correction.

1 14. The method of claim 1 wherein the independent keys of the keyboard have
2 exposed surfaces elevated above exposed surfaces of interstitial regions of the keyboard
3 between adjacent independent keys that together form a key combination corresponding to a
4 stored combination key output.

1 15. A method of providing input feedback in a device having a keyboard with a
2 matrix of independent keys having associated switches arranged in rows and columns,
3 wherein combinations of diagonally adjacent keys are associated with combination key
4 outputs, the method comprising

5 driving the rows in adjacent pairs while examining the columns for switch activation;
6 and,
7 in response to detecting switch activation in two adjacent columns while driving the
8 rows in adjacent pairs, determining a combination key output.

1 16. The method of claim 15 further including, prior to driving the rows in adjacent
2 pairs, driving the rows of key switches while searching on the columns for switch activity;
3 and then driving the rows in adjacent pairs in response to detection of an activated switch on
4 at least one of the columns.

1 17. The method of claim 16 wherein all rows of key switches are driven
2 simultaneously while searching on the columns for any switch activity.

1 18. The method of claim 16 further including, after determining the combination
2 key output, waiting until all columns are low before again driving all rows of switches.

1 19. The method of claim 15 further including, in response to detecting switch
2 activation in only one column while driving the rows in adjacent pairs, determining an
3 individual key output.

1 20. The method of claim 19 wherein determining the individual key output
2 includes
3 setting a first hit counter for keeping track of a number of cycles that an indicated key
4 is activated;
5 incrementing the first hit counter each cycle; and,
6 when the first hit counter has reached a predetermined number, registering an
7 independent key output associated with the indicated key.

1 21. The method of claim 20 further including, after registering the independent
2 key output, resetting the first hit counter and waiting until all columns are low before again
3 driving the rows of switches.

1 22. The method of claim 20 wherein the predetermined number is an equivalent of
2 approximately 20 to 30 milliseconds.

1 23. The method of claim 20 wherein the predetermined number is incorporated
2 into a learn mode.

1 24. The method of claim 23 wherein the learn mode includes increasing the
2 predetermined number in response to: delete key usage after an individual key, followed by
3 an input of an associated combination key.

1 25. The method of claim 20 wherein the predetermined number is approximately
2 200 milliseconds.

1 26. The method of claim 15 wherein the independent keys of the keyboard have
2 exposed surfaces elevated above exposed surfaces of interstitial regions of the keyboard
3 between adjacent independent keys corresponding to combinations of diagonally adjacent
4 keys associated with combination key outputs.

1 27. A method of determining input in a device having a keyboard with a matrix of
2 independent keys having associated switches in a known arrangement, wherein combinations
3 of adjacent keys are associated with combination key inputs, the method comprising
4 identifying independent keys of legitimate combination key inputs in association with a first
5 activated key, by

6 adding each of a predetermined set of numbers to a sequence number associated with
7 the activated key, to determine sequence numbers of legitimate combination-producing
8 independent keys associated with the activated key, the predetermined set of numbers based
9 upon the known switch arrangement; and then

10 identifying legitimate combination-producing independent keys in a table associating
11 keys and sequence numbers, from the determined sequence numbers.

1 28. The method of claim 27 further including, after identifying independent keys
2 of legitimate combination key inputs in association with a first activated key, and in response
3 to activation of one of the identified legitimate combination-producing independent keys,
4 registering an input associated with a combination of the first activated key and the activated
5 one of the identified legitimate combination-producing independent keys.

1 29. The method of claim 27 including, after identifying legitimate combination-
2 producing independent keys, specifically checking for activation of the identified legitimate
3 combination-producing independent keys.

1 30. The method of claim 27 wherein the key switches are arranged in rows and
2 columns, and wherein legitimate key combinations having associated inputs are
3 combinations of diagonally adjacent keys.

1 31. The method of claim 30 wherein the predetermined set of numbers consists of
2 values associated with $(R+1)$ and $(R-1)$, where R is a number of rows of the key matrix.

1 32. The method of claim 27 wherein checking for activation of legitimate
2 combination-producing independent keys comprises evaluating results of a scan from which
3 the first activated key is identified.

1 33. The method of claim 27 wherein the first activated key is identified on a first
2 scan of the key matrix, and wherein specifically checking for activation of the identified
3 legitimate combination-producing independent keys comprises scanning the matrix a
4 subsequent time.

1 34. The method of claim 33 wherein specifically checking for activation of the
2 identified legitimate combination-producing independent keys comprises scanning only a
3 single column adjacent a column containing the first activated key.

1 35. The method of claim 27 wherein the table associating keys and sequence
2 numbers contains extra sequence numbers not associated with switches of the key matrix.

1 36. The method of claim 35 wherein the extra sequence numbers are numerically
2 between sequence numbers associated with switches on opposite edges of the key matrix.

1 37. The method of claim 27 wherein the independent keys of the keyboard have
2 exposed surfaces elevated above exposed surfaces of interstitial regions of the keyboard
3 between adjacent independent keys corresponding to combinations of diagonally adjacent
4 keys associated with combination key outputs.

1 38. A method of providing input feedback in a device having a keyboard with a
2 matrix of independent keys having associated switches, wherein combinations of adjacent
3 keys are associated with combination key inputs, the method comprising
4 scanning the matrix for activated keys;
5 comparing scanned key states with key states from a prior scan of the matrix;
6 upon detection of a change in key states, analyzing the scanned key states, including
7 for scanned key states indicating only one active key, registering an
8 independent key input associated with the active key; and
9 for scanned key states indicating multiple active keys associated with a single
10 combination input, registering the combination key input associated with the multiple active
11 keys.

1 39. The method of claim 38 wherein detection of a change in key states comprises
2 detection of a change in number of keys activated.

1 40. The method of claim 38 further including, in response to detecting no change
2 in key states as a result of comparing scanned key states with key states from a prior scan of
3 the matrix, repeating the step of scanning the matrix for activated keys without said
4 analyzing of the scanned key states.

1 41. The method of claim 38 wherein analyzing the scanned key states further
2 includes, for scanned key states indicating multiple active keys not associated in combination
3 with a single combination input, registering an input associated with a stored personal
4 identification number.

1 42. The method of claim 38 wherein analyzing the scanned key states includes,
2 for scanned key states indicating two active keys, determining if the two active keys are
3 diagonally adjacent to one another and, if the two active keys are determined to be diagonally
4 adjacent to one another, registering a combination key input associated with the two active
5 keys.

1 43. The method of claim 38 wherein the independent keys of the keyboard have
2 exposed surfaces elevated above exposed surfaces of interstitial regions of the keyboard
3 between adjacent independent keys corresponding to combinations of diagonally adjacent
4 keys associated with combination key outputs.

1 44. A method of providing input feedback in a device having a keyboard with a
2 matrix of independent keys having associated switches, wherein combinations of adjacent
3 keys are associated with combination key inputs, the method comprising
4 scanning the matrix for activated keys;
5 generating a key count corresponding to how many keys are activated; and
6 evaluating the key count to determine whether to analyze other key state information.

1 45. The method of claim 44 wherein evaluating the key count comprises
2 comparing the key count to the numeral 'one', and, for key counts equal to one, analyzing
3 other key state information to determine which independent key is active.

1 46. The method of claim 44 wherein evaluating the key count comprises
2 comparing the key count to a stored key count from a previous scan of the matrix to
3 determine if the key count has changed.

1 47. The method of claim 44 wherein the independent keys of the keyboard have
2 exposed surfaces elevated above exposed surfaces of interstitial regions of the keyboard
3 between adjacent independent keys corresponding to combinations of diagonally adjacent
4 keys associated with combination key outputs.

1 48. A method of providing input feedback in a device having a keyboard with a
2 matrix of independent keys having associated switches, wherein combinations of adjacent
3 keys are associated with combination key inputs, the method comprising
4 scanning the matrix for activated keys;
5 in response to detecting that a key has been activated for a predetermined period of
6 time, registering an input associated with the activated key; and
7 in response to detecting that no keys are activated in a scan following a scan in which
8 a key was detected as activated but for a time less than the predetermined period of time,
9 registering an input associated with the activated key.

1 49. The method of claim 48 further including, following registering an input
2 associated with the activated key, resetting a timer associated with key activation time and
3 scanning the matrix again.

1 50. The method of claim 49 wherein the timer comprises a counter incremented
2 for each sequential scan in which a given key is active.

1 51. The method of claim 48 wherein the predetermined period of time is between
2 about 160 and 250 milliseconds.

1 52. An electronic device having a keyboard with a matrix of independent keys
2 having associated switches and configured to perform the method of claim 1.

1 53. An electronic device having a keyboard with a matrix of independent keys
2 having associated switches arranged in rows and columns, wherein combinations of

3 diagonally adjacent keys are associated with combination key outputs, and wherein the
4 device is configured to perform the method of claim 15.

1 54. An electronic device having a keyboard with a matrix of independent keys
2 having associated switches in a known arrangement, wherein combinations of adjacent keys
3 are associated with combination key inputs, and wherein the device is configured to perform
4 the method of claim 27.

1 55. An electronic device having a keyboard with a matrix of independent keys
2 having associated switches, wherein combinations of adjacent keys are associated with
3 combination key inputs, and wherein the device is configured to perform the method of claim
4 38.

1 56. An electronic device having a keyboard with a matrix of independent keys
2 having associated switches, wherein combinations of adjacent keys are associated with
3 combination key inputs, and wherein the device is configured to perform the method of claim
4 44.

1 57. An electronic device having a keyboard with a matrix of independent keys
2 having associated switches, wherein combinations of adjacent keys are associated with
3 combination key inputs, and wherein the device is configured to perform the method of claim
4 48.